Air Surveillance Monitoring

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Introduction

Lawrence Livermore National Laboratory performs ambient air monitoring to evaluate its compliance with local, state, and federal laws and regulations and to ensure that human health and the environment are protected from hazardous and radioactive air emissions. Federal environmental air quality laws and U.S. Department of Energy (DOE) regulations include Title 40 of the Code of Federal Regulations (CFR) Part 61, the National Emissions Standards for Hazardous Air Pollutants (NESHAPs) section of the Clean Air Act, and applicable portions of DOE Orders 5400.1 and 5400.5. The *Environmental Regulatory Guide for Radiological Effluent Monitoring and Environmental Surveillance* (U.S. DOE 1991) provides the guidance for implementing DOE Orders 5400.1 and 5400.5. In general, the airborne substances for which LLNL monitors are at levels far below regulatory standards.

LLNL monitors ambient air to determine if airborne radionuclides or hazardous materials are being released by Laboratory operations, what the concentrations are, and what the trends are in the LLNL environs. In the air monitoring program, LLNL collects particles on filters and chemically traps vapors on a collection medium. Concentrations of various airborne radionuclides (including particles and tritiated water vapor) and beryllium are measured at the Livermore site, Site 300, and at off-site locations throughout the Livermore Valley and in the City of Tracy. In addition, some point sources and diffuse, or nonpoint sources, are monitored to fulfill NESHAPs requirements (Harrach et al. 2002).

Methods

Monitoring networks are established for surveillance of air particulates and tritium in the environs of LLNL and Site 300, as well as in the surrounding Livermore Valley and in the City of Tracy. The sampling locations for each monitoring network are listed in **Table 5-1** and shown on **Figure 5-1**, **Figure 5-2**, and **Figure 5-3**. All monitoring networks use continuously operating samplers. The air particulate sampling network uses glass-fiber, cellulose, and membrane filters, while the collection medium for tritium is silica gel.

Particulate filters are changed each week at all locations, and tritium samples are changed every two weeks. Duplicate quality control samplers operate in parallel with the permanent sampler at a given site, and these samples are analyzed to confirm results.

Air Particulate Sampling Locations

All air samplers are positioned to provide reasonable probability that any significant concentration of radioactive or beryllium effluents from LLNL operations will be detected.

The Livermore site radiological air particulate sampling network (see **Figure 5-1**) consists of seven samplers at the perimeter with one (CRED) serving as the sitewide maximally exposed individual (SW-MEI) for NESHAPs reporting purposes. CRED is also located in the southeast quadrant in an area of known plutonium contamination attributed to historic operations, which included the operation of solar evaporators for plutonium-containing liquid waste.

The Livermore Valley network (see **Figure 5-2**) consists of air particulate samplers located in all directions from the Livermore site. For the purposes of data analysis, four samplers (FCC, FIRE, HOSP, and CHUR) located in the least prevalent wind directions are considered to be upwind or representative of background locations. An additional upwind sampler is located in another area of special interest, the Livermore Water Reclamation Plant (LWRP), because of plutonium releases in 1967 and earlier to the sanitary sewer system with subsequent soil contamination and potential resuspension (see the "Livermore Valley Surface Soil Results" section of Chapter 10 for a discussion of this). Four samplers (PATT, ZON7, TANK, and AMON) are located in the most prevalent downwind directions that are considered most likely to be affected by Laboratory operations.

Livermore site beryllium monitoring continued in 2001 at all perimeter locations (except CRED). To satisfy beryllium reporting requirements and determine the effects of the Laboratory's beryllium operations, LLNL conducted a technical assessment of the beryllium monitoring locations at Site 300 in 1997. Although there is no requirement to sample for beryllium at Site 300, LLNL has decided, as a best management practice, to continue beryllium monitoring at three locations on site (801E, EOBS, GOLF) and at one location in the City of Tracy (TFIR) (see **Figure 5-3**).

The Site 300 air particulate monitoring network includes eight sampling units placed around the site and near firing tables and one in downtown Tracy (see **Figure 5-3**). Due to the remoteness of Site 300 and the difficulties with weekly access, monitoring sites were chosen based on safety, power, and access considerations. COHO serves as the SW-MEI for NESHAPs reporting purposes.

Two sampling systems were added in the Livermore Valley in July 1997 as part of the new low-volume radiological air particulate sampling network. The samplers are situated at FCC and HOSP and are generally upwind of the Livermore site. The results are used to establish background levels of gross

Table 5-1. Sampling locations and type and frequency of analyses for ambient air

Livermore site						
	Weekly gross alpha & beta (low volume)	Weekly gross alpha & beta (high volume)	Monthly $^{239+240}$Pu	Monthly Gamma & $^{235, 238}$U[a]	Monthly Beryllium	Biweekly Tritium
Network	Air particulate					Air vapor
Collection Media	Membrane	Glass fiber			Cellulose	Silica gel
SALV		X	X	X	X	X
MESQ		X	X	X	X	X
CAFE		X	X	X	X	X
MET		X	X	X	X	X
VIS		X	X	X	X	X
COW		X	X	X	X	X
CRED		X	X			
DWTF						X[b]
B292						X
B331						X
B514						X
B624						X
POOL						X
VET						X
ZON7		X	X			X
PATT		X	X			X[c]
CHUR		X	X			
AMON		X	X			X
FCC	X	X	X			
HOSP	X	X	X			X
LWRP		X	X			
FIRE		X	X			X
TANK		X	X			
Site 300						
		Weekly gross alpha & beta (high volume)	Monthly $^{235, 238}$U	Monthly Gamma & $^{239+240}$Pu[a]	Monthly Beryllium	Biweekly Tritium
Network		Air particulate				Air vapor
Collection Media		Glass fiber			Cellulose	Silica gel
EOBS		X	X	X	X	
ECP		X	X	X		
WCP		X	X	X		
GOLF		X	X	X	X	
NPS		X	X	X		
WOBS		X	X	X	X	
801E		X	X	X		
COHO		X	X			X
TFIR		X	X		X	

a Perimeter composites samples include portions of weekly filters from the specified locations.

b New monitoring station started October 2001.

c PATT replaced XRDS (foir tritium only). Monitoring began February 2001.

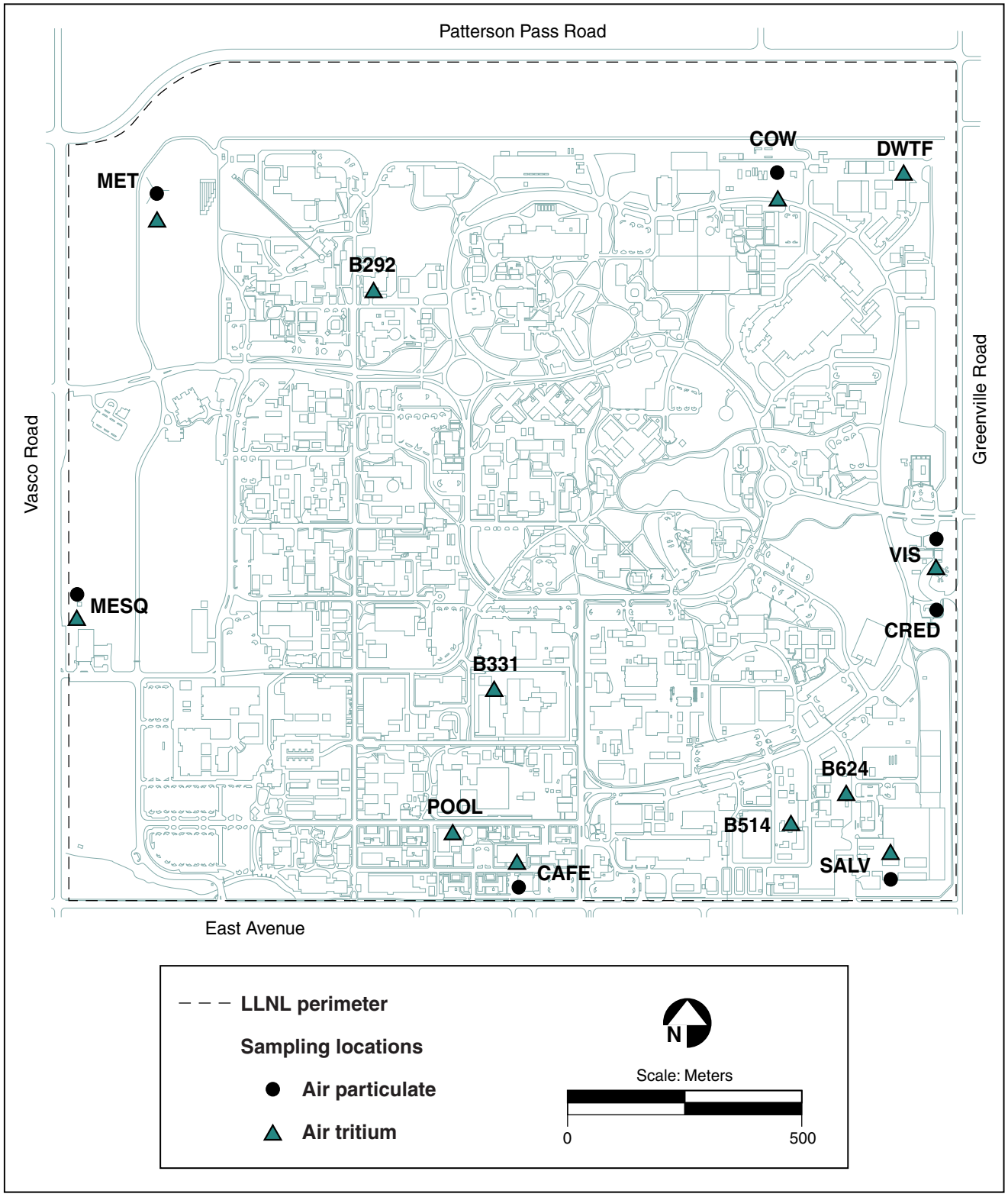

Figure 5-1. Air particulate and tritium sampling locations on the Livermore site, 2001

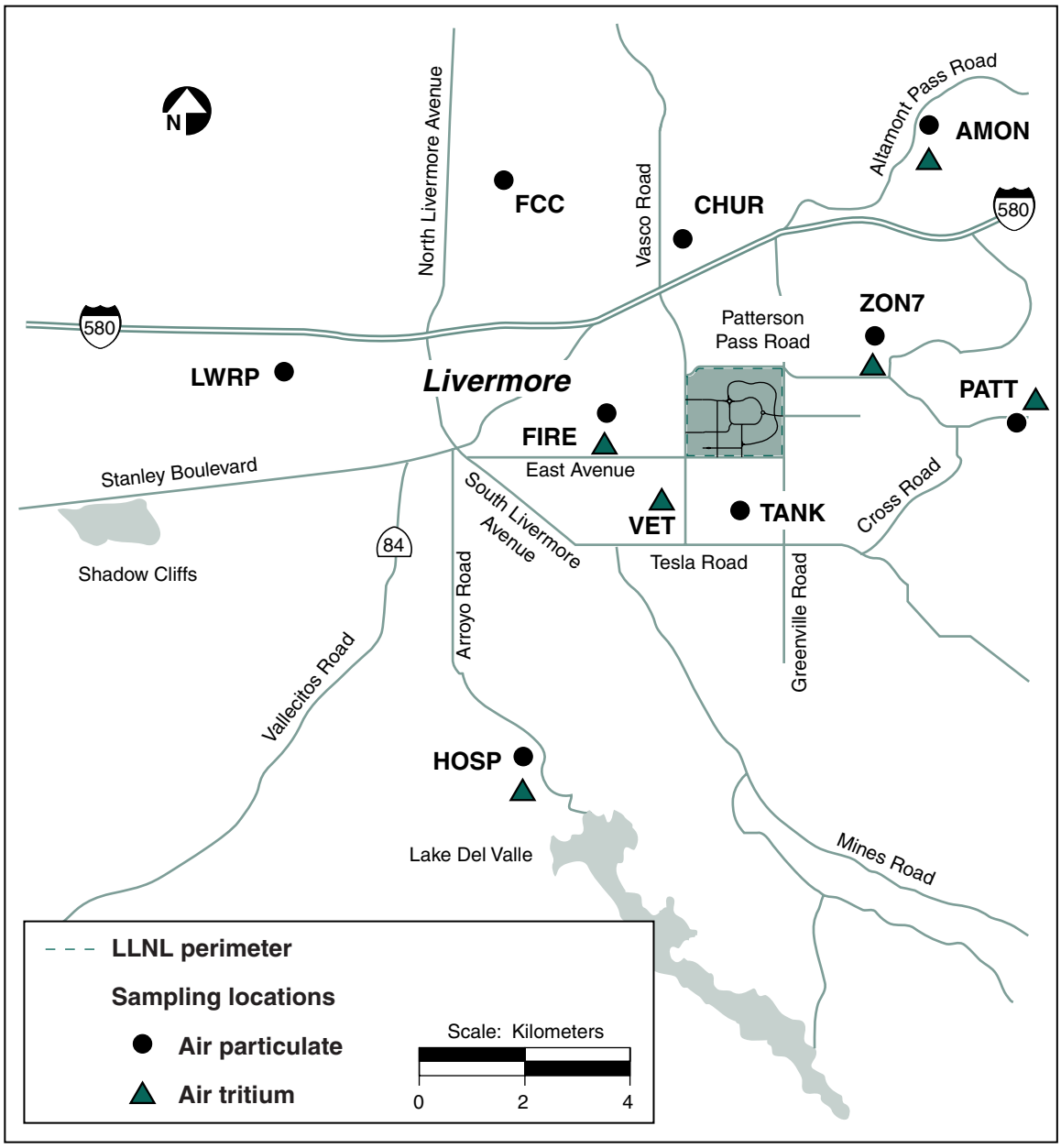

Figure 5-2. Air particulate and tritium sampling locations in the Livermore Valley, 2001

alpha and beta activity for direct comparison to emissions from the air effluent samplers (see Chapter 4). The low-volume sampling systems are very similar to the air-effluent samplers used in facilities, including sampling system design, sampler operation, sampler flow rate, filter media, sample tracking, sample analysis, and processing of results.

Air Tritium Sampling Locations

LLNL also maintains 12 continuously operating airborne tritium samplers on the Livermore site (see **Figure 5-1**), 6 samplers in the Livermore Valley (see **Figure 5-2**), and 1 sampler at Site 300 (see

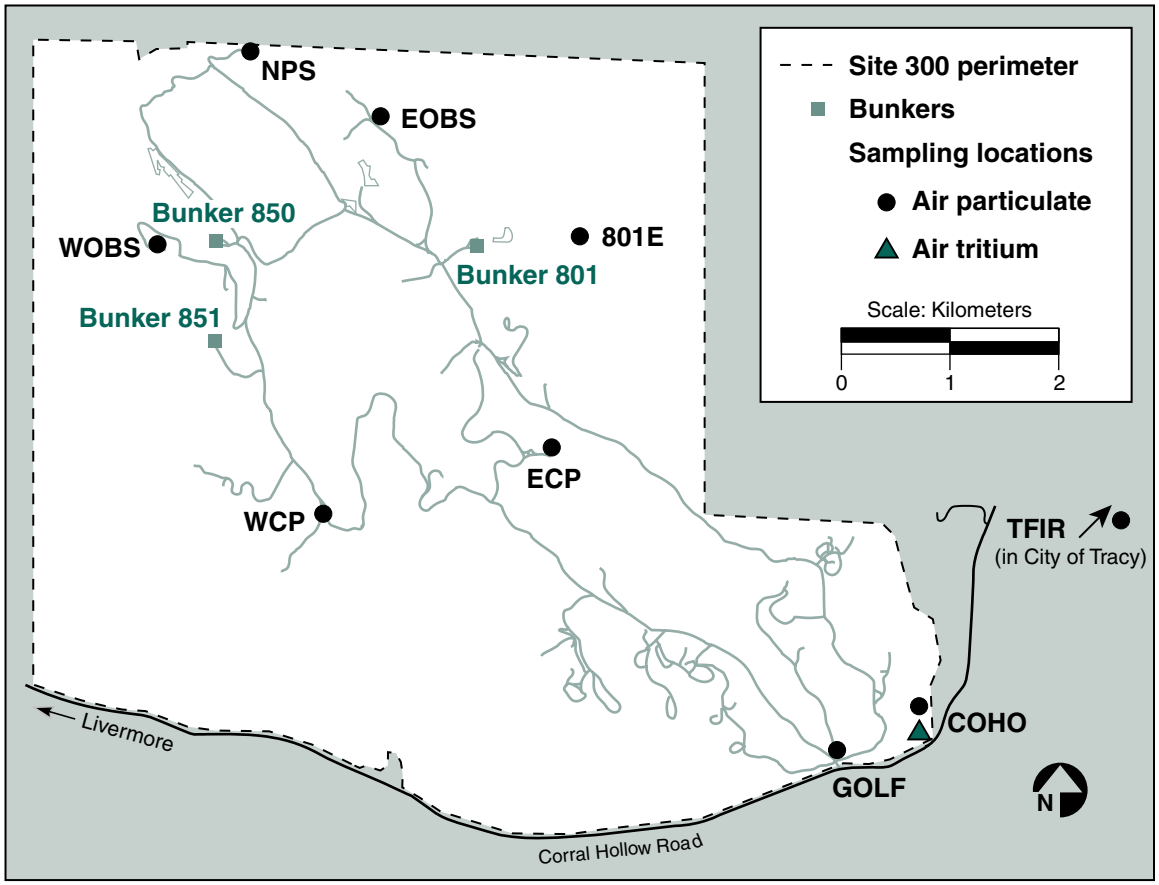

Figure 5-3. Air particulate and tritium sampling locations at Site 300 and off-site, 2001

Figure 5-3) to assess current activities that influence environmental impacts. Four of the Livermore site locations (B331, B292, B514, and B624) monitor diffuse tritium emissions.

Radiological Analysis

As outlined in *Environmental Regulatory Guide for Radiological Effluent Monitoring and Environmental Surveillance* (U.S. DOE 1991), gross alpha, gross beta and gamma emitters on air filters are used as trend indicators; specific radionuclide analysis is done for plutonium and uranium. Radiological analytical results are reported as a measured activity per volume of air. Regardless of whether any activity is considered to have been detected, the result of the analysis is reported.

Particle size distribution on air samples is not determined because the estimated effective dose equivalent to the maximally exposed individual (from the total particulate) is well below the 0.01-mSv (1-mrem) allowable limit as discussed in the above-mentioned environmental regulatory guide.

Gross alpha and gross beta activities are determined by gas flow proportional counting; plutonium and uranium isotopes by alpha spectrometry; gamma emitters by gamma spectroscopy; and tritium by liquid scintillation.

In 2001, a correction factor was applied to tritium concentrations to account for dilution of the collected tritium from air moisture by a heretofore

unknown quantity of water in supposedly dry silica gel. On average, the corrected concentrations are 1.6 times higher than uncorrected concentrations. Further details of the monitoring and analytical methods for ambient air are provided in Chapter 5 of the Data Supplement.

For air, Derived Concentration Guides (DCGs) specify the concentrations of radionuclides that can be inhaled continuously 365 days a year without exceeding the DOE primary radiation protection standard for the public, which is 1 mSv/y (100 mrem/y) effective dose equivalent (DOE Order 5400.5). (Chapter 13 provides an explanation of this and other units of dose.) Each table in this chapter presents the DCG and the percent of the DCG for the given isotope. In all air samples, the maximum concentration for any sample is less than 0.2% of the DCG.

Results

This section discusses the air monitoring results from all air surveillance locations at the Livermore site, Site 300, and all off-site surveillance locations.

In April 1997, the radiological air particulate sampling filter media were changed from cellulose to glass fiber; however, blank glass-fiber filters contain nontrivial amounts of some naturally occurring radiological isotopes (Althouse 1998) including uranium-235, uranium-238, potassium-40, radium-226, radium-228, and thorium-228. In fact, the amounts of these naturally occurring isotopes contained in these filters is often greater than the amounts of the isotopes being filtered from the air.

LLNL adjusts the gross measured concentrations of these isotopes according to U.S. Environmental Protection Agency (EPA) procedures (Eadie and Bernhardt 1976). LLNL staff subtracts the appropriate blank filter content from the gross analytical result to obtain a corrected net result. This subtraction of the background filter content results in highly variable uranium-235 to uranium-238 ratios. Historically, these ratios have been used to determine the presence of naturally occurring uranium; however, this variability makes the ratio results useless. Therefore, the ratios are not reported in 2001. Changes in filter media and analytical methodology were implemented in 2002. These changes should once again enable the use of the uranium ratios for identification of natural uranium.

Livermore Site

Airborne Radioactivity

Figure 5-4 shows the two-year history of monthly gross alpha and gross beta median activities for the LLNL perimeter, Livermore Valley, and Site 300 sampling locations. Detailed location results for the high volume network for gross alpha and gross beta concentrations are summarized in the Data Supplement Tables 5-1, 5-2, and 5-3. The median concentrations, interquartile ranges (IQR), and maximum concentration for each location are provided in addition to the monthly median for each area of interest.

The typical gross alpha activity (annual median value) for the LLNL perimeter is 4.6×10^{-5} Bq/m^3 (1.2×10^{-15} Ci/m^3); for the upwind Livermore Valley stations, the value is 5.2×10^{-5} Bq/m^3 (1.4×10^{-15} Ci/m^3), while the downwind Livermore valley stations increase only slightly at 5.6×10^{-5} Bq/m^3 (1.5×10^{-15} Ci/m^3). The maximum values for all gross alpha and gross beta data occurred in January.

The January high values are a continuation of an increase in the latter part of 2000 and coincide with the lack of rain into the beginning of the year. Both the gross alpha and gross beta data decrease significantly in February with the increase in rainfall. The

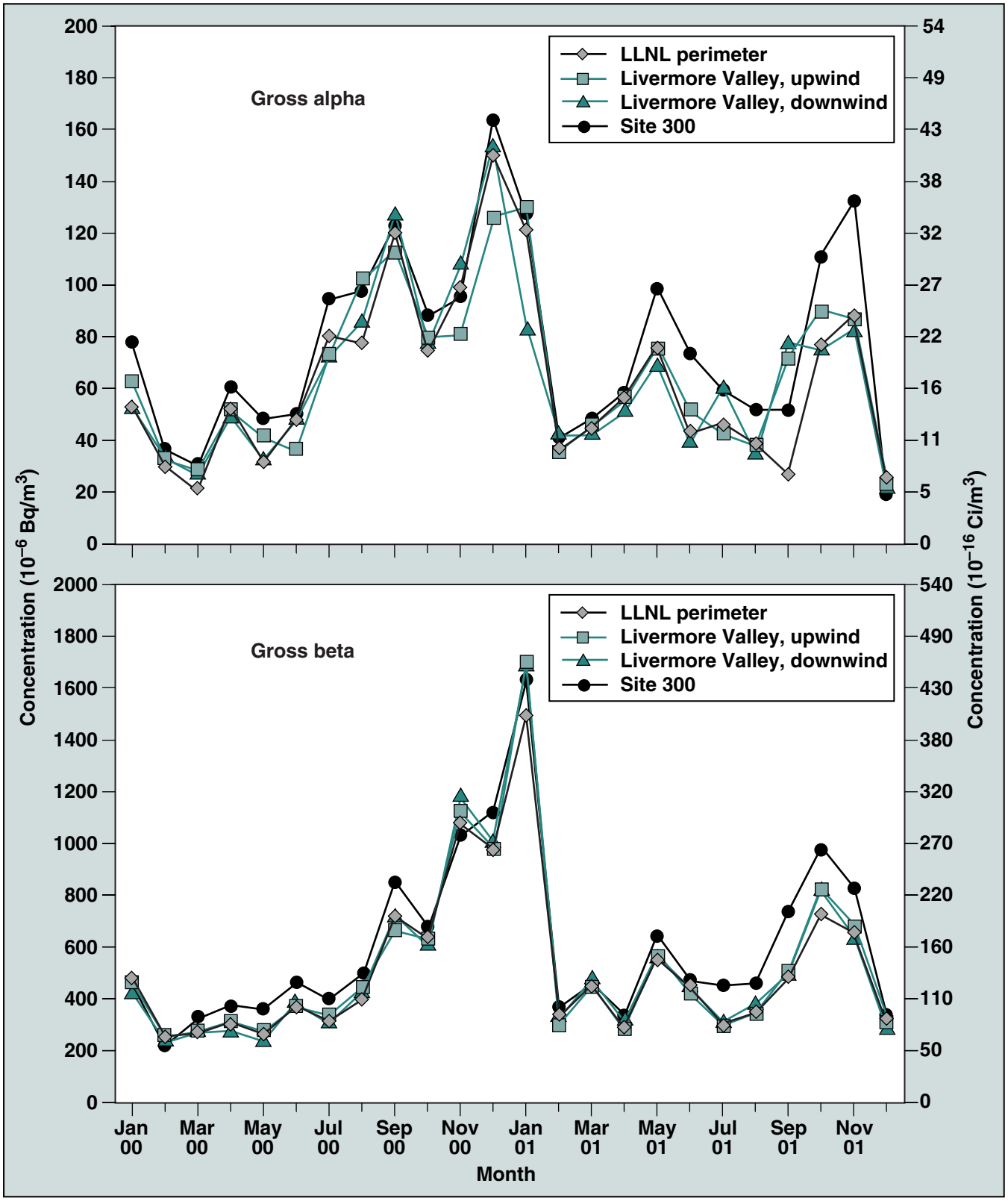

Figure 5-4. Two-year history of the median gross alpha and gross beta activities for all particulate samples grouped by area, 2000-2001

gross beta activity ranged from the lowest annual median value recorded at an upwind Livermore Valley station (FCC) at 4.1×10^{-4} Bq/m^3 (1.1×10^{-14} Ci/m^3) to the highest value of 5.0×10^{-4} Bq/m^3 (1.3×10^{-14} Ci/m^3) at a downwind Livermore station (AMON). The LLNL median perimeter value was between the upwind and downwind valley values.

The primary sources of the alpha and beta activities are the naturally occurring radioisotopes of uranium and thorium, and any residual fallout from atmospheric weapons testing and the 1986 Chernobyl reactor accident. These data follow a similar pattern to the low-volume gross alpha and gross beta data.

Composite samples for the Livermore site and Site 300 are analyzed for over 40 gamma-emitting radionuclide concentrations in air. Of those isotopes, only beryllium-7, a naturally occurring product primarily formed as a result of cosmic ray interactions, was consistently detected. Cesium-137 was detected in the June sample with a concentration of 1.0×10^{-6} Bq/m^3 (2.7×10^{-17} Ci/m^3) (less than 0.00001% of the DCG). The primary source of cesium-137 is long-term global fallout and fallout resuspension. The beryllium-7 data are shown in Table 5-2. All other gamma results were less than the detection limit. By analyzing air samples for gamma-emitting radionuclides, LLNL verifies that there is no evidence of release of the small inventories of mixed fission products and radiochemical tracers used at LLNL and also obtains baseline data on global fallout. Air filter results indicate there were no significant gamma emitting isotopes detected as a result of LLNL activities.

Table 5-4 in the Data Supplement shows the concentrations of airborne plutonium-239+240 on air filters from the LLNL perimeter locations. Of the over 80 samples analyzed for plutonium along the perimeter in 2001, only 3 samples (one at each of these locations: CRED, MET, and VIS) detected plutonium. Of these samples, the highest value was detected during October at MET, located on the west perimeter of LLNL. This value of 9.5×10^{-7} Bq/m^3 (2.6×10^{-17} Ci/m^3) is still only 0.13% of the DCG (7.4×10^{-4} Bq/m^3). The sample for the following month for MET was well within the historical range for this location. The annual median plutonium activity for this location and all perimeter locations was 4.7×10^{-9} Bq/m^3 (1.3×10^{-19} Ci/m^3) or 0.0006% of the DCG.

Table 5-2. Beryllium-7 activity in air particulate samples for the Livermore site and Site 300 composites, 2001

Month	LLNL Composite[a] (10^{-3} Bq/m^3)	Site 300 Composite[b] (10^{-3} Bq/m^3)
Jan	0.641 ± 0.0293	1.04 ± 0.113
Feb	1.28 ± 0.0445	0.693 ± 0.0286
Mar	1.46 ± 0.0476	0.575 ± 0.0266
Apr	0.852 ± 0.0941	0.979 ± 0.0363
May	0.957 ± 0.0328	1.29 ± 0.0375
Jun	1.45 ± 0.159	2.26 ± 0.274
Jul	0.681 ± 0.0790	1.33 ± 0.148
Aug	0.436 ± 0.0624	0.886 ± 0.106
Sep	1.46 ± 0.166	2.25 ± 0.245
Oct	1.49 ± 0.164	1.47 ± 0.156
Nov	0.914 ± 0.100	1.06 ± 0.121
Dec	0.530 ± 0.0579	0.491 ± 0.0554
Median	0.936	1.05
IQR[c]	0.782	0.527
Maximum	1.49	2.26
Percent of DCG	6.24×10^{-5}	7.00×10^{-5}
DCG (Bq/m^3)	1500	

a Livermore composite consists of samples from SALV, MESQ, CAFE, MET, VIS, and COW. See **Figure 5-2.**

b Site 300 composite consists of samples from 801E, EOBS, ECP, GOLF, NPS, WCP, and WOBS. See **Figure 5-3**.

c IQR= Interquartile range

Table 5-5 in the Data Supplement shows the monthly plutonium-239+240 data for the Livermore Valley samples. Over 100 samples were analyzed for plutonium from off-site locations. Two downwind samples and six upwind samples detected plutonium. The highest downwind detection of 7.3×10^{-7} Bq/m^3 was from the October sample located at TANK, representing 0.10% of the DCG. The highest upwind detection was also collected during October from the FIRE location and registered 1.2×10^{-7} Bq/m^3 or 0.02% of the DGC.

The maximum plutonium values in Tables 5-4 and 5-5 of the Data Supplement were further investigated. Since the analytical process involves total consumption of the air filter, reanalysis is not possible. To investigate high composite values on our filters, weekly gross alpha and gross beta (GAB) data for the same period are checked. These GAB data for the high plutonium composite showed no significant increase. In addition, all data for plutonium in the following month returned to typical historical values.

Figure 5-5 shows the monthly median plutonium-239+240 results for the Livermore locations. While fewer air samples positively detected plutonium in 2001 compared to 2000, their annual median values were similar. The highest values for all areas of interest ocurred during October, which is typical for particulate data with low activity and usually the result of resuspended mass particle buildup. LLNL is investigating the effect of particle loading and its effect on detected activities.

Figure 5-6 shows the historical annual median concentrations of plutonium-239+240 for locations SALV (on site) and FCC (off site) from 1982 to 2001. The graph also plots the current achievable detection limit. Data below the detection limit is an estimated activity value, meaning the value is somewhere between the reported estimated value and zero. Location FCC represents an upwind background location, and SALV represents a perimeter location. The annual median concentration for FCC (9.6×10^{-9} Bq/m^3) is the highest annual median value from an off-site location in the Livermore Valley and represents 0.001% of the DCG.

Figure 5-6 uses a log scale, and for the years when a negative median concentration was calculated, the lowest positive value was plotted. The higher values in the past at SALV may be attributed to historical activities at LLNL. The general downward trend at both locations is likely the result of decreasing residual global fallout. The apparent increase in the annual median at both locations in 2000 and 2001 is most likely the result of the change in the analytical laboratory. (Changes in the analytical laboratories often result in changes to the minimum detection limit.)

As the result of a network assessment and reduced operations involving uranium, Livermore perimeter site-specific uranium analysis was eliminated because there are no significant sources of uranium on site. Instead, a composite from six perimeter locations (CAFE, COW, MESQ, MET, SALV, and VIS) is created to determine uranium activities at LLNL while specific locations at Site 300 receive uranium analysis. The Livermore composite and Site 300 data are shown in **Table 5-3**. Only one sample for the Livermore composite had positive results for both uranium-235 and uranium-238 and this sample had uncertainties.

Site 300 data are discussed in the "Site 300" section of this chapter.

The low-volume radiological air sampling locations FCC and HOSP have annual medians for gross alpha and gross beta activity of 3.6×10^{-5} Bq/m^3 (9.7×10^{-16} Ci/m^3) and 5.4×10^{-4} Bq/m^3 (1.5×10^{-14} Ci/m^3), respectively. (See Data Supplement Table 5-6 for monthly median data.)

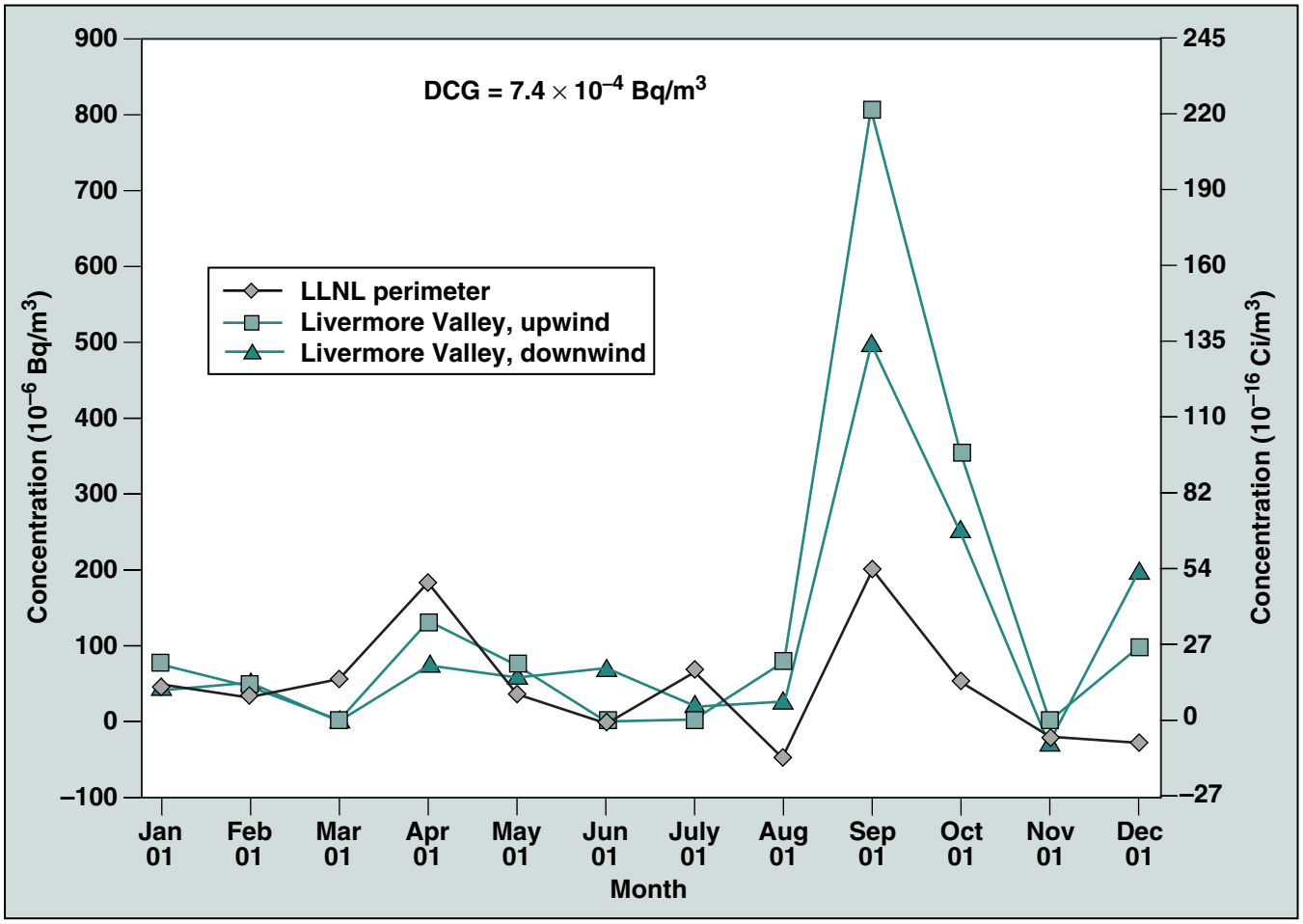

Figure 5-5. Monthly median concentrations of plutonium-239+240 in air particulate samples, 2001

These gross alpha values are similar to those reported from the high-volume sampling systems at the same locations.

Tritium data presented in **Table 5-4** summarize the biweekly tritium data presented in Tables 5-7, 5-8, 5-9 and 5-14 of the Data Supplement. Locations are grouped by expected concentrations of tritium. The highest concentrations of tritium are from samplers on the Livermore site near locations of diffuse tritium (B292, B331, B514, and B624). The sources of tritium in these locations are mostly stored containers of tritium waste or tritiated contaminated equipment, but B292 is near a pine tree acting as a diffuse source of tritium because its roots are growing in water contaminated with tritium from an underground retention tank that leaked (see Chapter 11). Median concentrations for 2001 from all the diffuse-source samplers are lower than those from 2000 when uncorrected data are compared. Corrected concentrations of tritium that account for dilution by bound water in silica gel were only calculated for 2001. Because the corrected concentrations are about 1.6 times higher than uncorrected concentrations, a comparison of trends can only be made between uncorrected data from 2000 and uncorrected data from 2001.

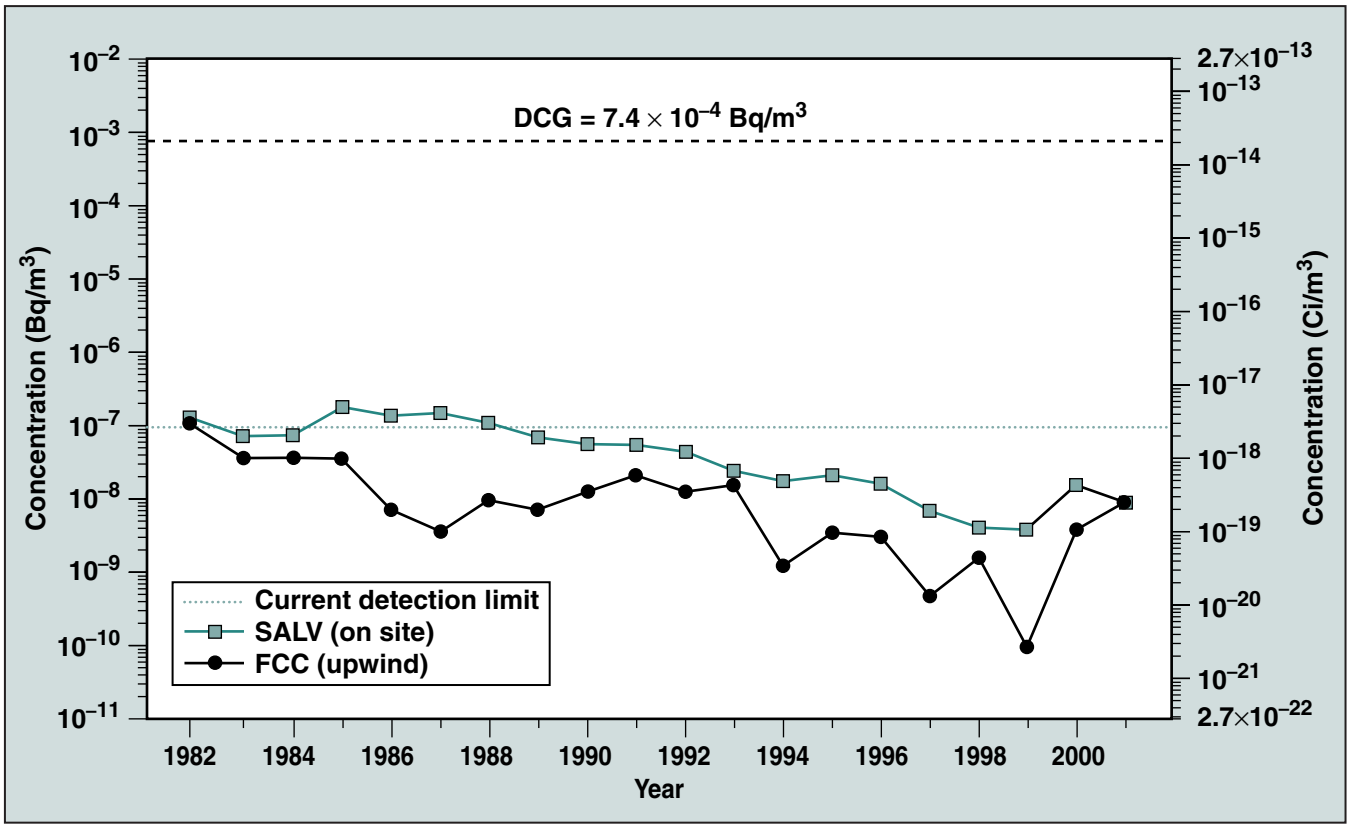

Figure 5-6. Calculated annual median concentrations of plutonium-239+240 for SALV and FCC with current detection limit and DCG identified, 2001

Samplers on the perimeter of the Livermore site exhibit the next highest air tritium concentrations, which are much lower than those at the locations of the diffuse sources. Of the perimeter locations, POOL exhibits the highest concentrations (Table 5-7, Data Supplement), and yet the POOL results are statistically different at the 5% significance level (Games-Howell 1976) from those of the sampler at B292, which has the lowest concentrations of the diffuse-source samplers. Median concentrations for 2001 for all the perimeter locations are uniformly less than those for 2000 when uncorrected results are compared. This corresponds to lower emissions from the Tritium Facility as well as from all the diffuse sources.

Perimeter concentrations for 2001 (even when data from POOL are omitted) are statistically higher than concentrations of tritium in air from the Livermore Valley. Sampling locations in the Livermore Valley demonstrate that LLNL tritium has an insignificant impact past the perimeter fence. Seventy-six percent of the Valley samples were below the limits of detection. The uncorrected median concentrations for the Valley locations for 2001 are uniformly lower than those for 2000 except for HOSP. Because all median concentrations from the Valley samplers are less than detection limits for 2001 and 2000, with the exception of ZON7, meaningful comparison of results cannot be made. When HOSP and Site 300 concentrations for 2001 are compared, there is no statistical

Table 5-3. Summary of uranium mass concentration in air samples, 2001

Location[a]	Uranium-235 (10^{-7} μg/m^3)[b]				Uranium-238 (10^{-5} μg/m^3)[c]			
	Median	IQR[d]	Maximum	Percent of DCG[e]	Median	IQR[d]	Maximum	Percent of DCG[e]
801E	4.06	6.84	58.2	0.000864	3.51	7.31	70.3	0.0117
COHO	3.90	4.75	25.0	0.000830	2.74	2.44	8.18	0.00913
ECP	2.96	12.0	36.5	0.000630	2.60	6.05	6.86	0.00865
EOBS	4.71	9.21	46.0	0.00100	1.30	7.27	68.9	0.00433
GOLF	–0.355	8.62	16.5	0.00351	1.84	1.64	8.61	0.00612
NPS	5.14	17.3	47.7	0.00109	0.891	3.78	66.5	0.00297
TFIR	4.86	9.05	21.1	0.00103	5.08	6.43	14.1	0.0169
WCP	–0.170	4.88	26.8	0.00570	3.44	1.14	47.7	0.0115
WOBS	0.230	5.78	22.9	0.0000490	2.93	3.76	32.9	0.00977
Livermore composite	–6.81	5.16	8.90	0.00189	–5.39	6.15	0.100	0.000390

Note: The negative values occur when the instrument or filter background median is greater than sample activity. See Chapter 14.

a See **Figure 5-3** for sampling locations at Site 300. Livermore composite consists of samples from CAFE, COW, MESQ, MET, SALV, and VIS (**Figure 5.1**).

b Uranium-235 activities in Bq/m^3 can be determined by dividing the mass in μg/m^3 by 12.5.

c Uranium-238 activities in Bq/m^3 can be determined by dividing the mass in μg/m^3 by 80.3.

d IQR = Interquartile range

e Derived Concentration Guides (DCG) for activity in air are 0.3 μg/m^3 for uranium-238 and 0.047 μg/m^3 for uranium-235. Percent DCG was calculated from median value, unless median value was negative; in such cases percent DCG was calculated from the maximum value.

Table 5-4. Tritium in air samples, 2001

Sampling locations[a]	Detection frequency[b]	Median	Interquartile range (mBq/m^3)	Maximum (mBq/m^3)	Percent of DCG[c]	Median Dose[d] (nSv)
Diffuse on-site sources	96/101	270	1300	4600	7.3×10^{-3}	57
Livermore perimeter	130/172	35	44	170	9.4×10^{-4}	7.3
Livermore Valley	34/142	8.0	17	52	2.2×10^{-4}	1.7
Site 300	2/25	–2.5	13	17	1.35×10^{-5}[e]	0.10[e]

a See **Figures 5-1**, **5-2**, and **5-3** for sample locations.

b Detection frequency is shown as the number of samples with results above the detection limit relative to the total number of samples.

c DCG = Derived Concentration Guide of 3.7 x 10^6 mBq/m^3 for tritium in air. Percent is calculated from the median concentration.

d Dose is calculated for inhalation (see Appendix A).

e Percent DCG and dose were derived from the lowest positive air concentration, because the median was negative.

difference between them. Both locations may be considered background locations unaffected by local sources of atmospheric tritium.

Beryllium in Air

The median concentrations of airborne beryllium for the Livermore site perimeter sampling locations are plotted in Figure 5-7. (See Data Supplement Table 5-10 for monthly data.) The highest value of 31.5 pg/m^3 was found in the August composite at location CAFE. The median concentration for this location is 16.7 pg/m^3, 0.17% of the monthly ambient concentration limit (ACL) of 10,000 pg/m^3 established by the Bay Area Air Quality Management District (BAAQMD) and the EPA. The median for all Livermore perimeters samples for 2001 was 11.6 pg/m^3 (0.12% of the ACL).

Figure 5-8 is a plot of the median beryllium concentration at the Livermore site perimeter from 1975 through 2001. The decrease in median concentration in 1993 and the slight increase in 1999 were the result of a change in the analytical

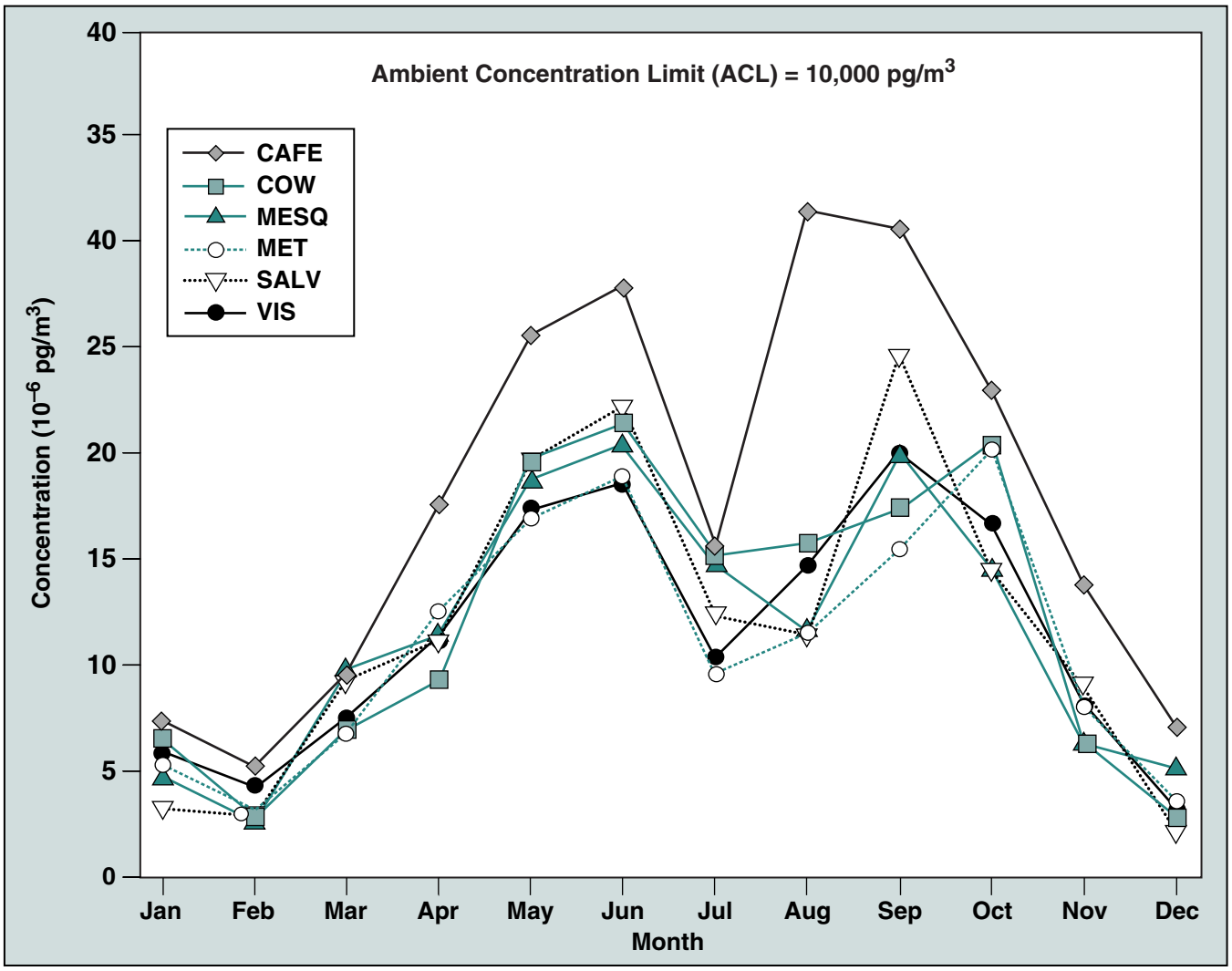

Figure 5-7. Monthly median concentration of beryllium in air particulate samples

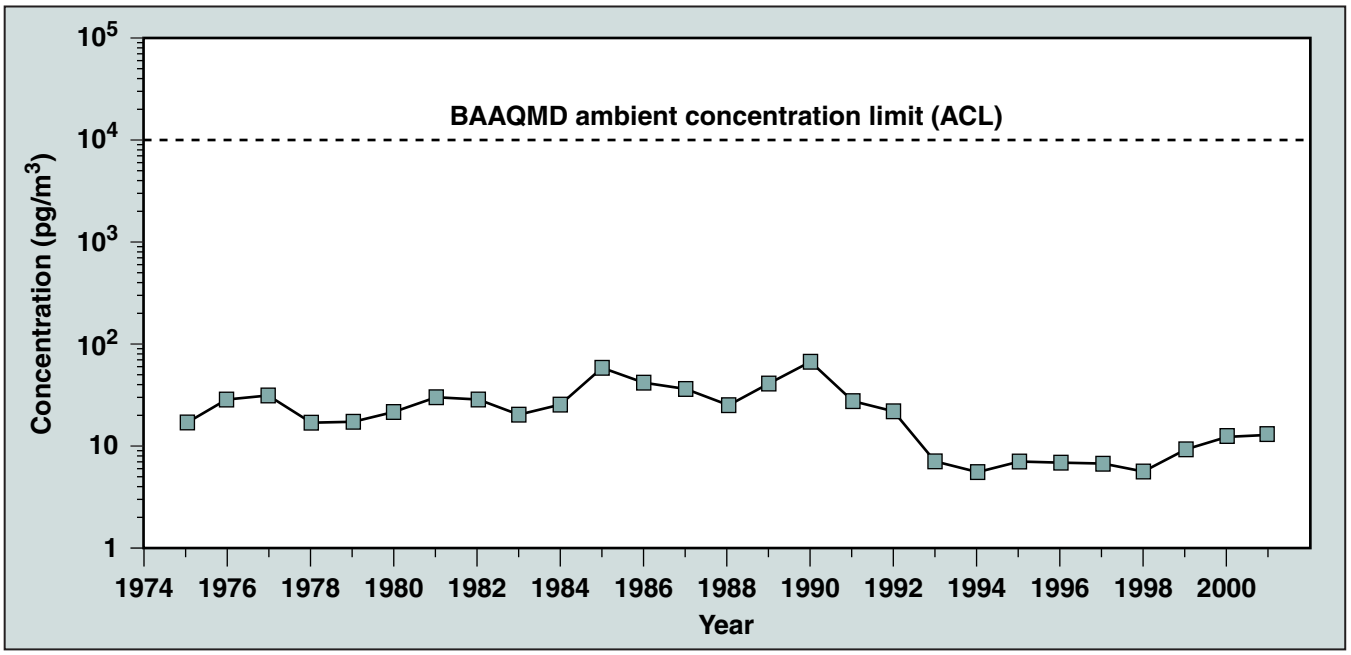

Figure 5-8. Median concentration of beryllium in air particulate samples taken at the Livermore site perimeter, 1975–2001

laboratory used to perform this analysis. (Changes in the analkytical laboratories often result in changes to the minimum detection limit.) The overall median concentration from 1975 through 2001 was calculated to be 0.18% of the ACL.

Site 300

Airborne Radioactivity

Table 5-11 in the Data Supplement shows the monthly gross alpha and gross beta median, IQR, and maximum for sampling locations at Site 300, as well as the monthly median for all Site 300 locations. The monthly median gross alpha and gross beta concentrations are plotted in **Figure 5-4** along with the Livermore areas of interest.

The Site 300 gross alpha and gross beta results show a similar pattern to those found at the Livermore site. Generally, Site 300 has the highest median values for both gross alpha and gross beta. This is attributed to the abundance of uncovered soils found at the site. Site 300 has fewer structures and buildings and less pavement, compared to Livermore locations, thereby enabling greater mass loading of resuspended particles on air filters. The median gross alpha activity is 6.3×10^{-5} Bq/m^3 (1.7×10^{-15} Ci/m^3). The median gross beta activity is 5.1×10^{-4} Bq/m^3 (1.4×10^{-14} Ci/m^3). These values are similar to those obtained from monitoring data during the past several years.

The primary sources of observed gross alpha and gross beta activity are naturally occurring radioisotopes of uranium and thorium, their decay products, and any residual fallout from atmospheric weapons testing and the 1986 Chernobyl reactor accident.

Monthly Site 300 composite samples are scanned for over 40 gamma emitting nuclides, and like the Livermore perimeter samples, only beryllium-7 was

consistently detected. Table 5-2 lists the annual median activity, IQR, maximum, the percent of the DCG, as well as the DCG, for beryllium-7 from Site 300.

The monthly median value for beryllium-7 from Site 300 composites was 1.0×10^{-3} Bq/m^3. Sodium-22 was detected in 2 samples (January and November) with the highest value of 6.3×10^{-7} Bq/m^3 (less than 0.000002% of the DCG). The May composite had a positive detection of radium-228 (4.1×10^{-6} Bq/m^3) which was 0.01% of the DCG. No other gamma isotopes were detected in the Site 300 composite samples. Of the nuclides detected, all are naturally occurring.

A composite of all Site 300 onsite locations is analyzed for plutonium-239+240 (see Data Supplement Table 5-12 for monthly data). The highest concentration of plutonium-239+240 was recorded in the March composite at a level of 9.8×10^{-9} Bq/m^3 (5.1×10^{-19} Ci/m^3). This value was a calculated value with an uncertainty of 100% and not considered a detection (see Chapter 14 for further details on detection criteria).

As the result of a network assessment, and because Site 300 has uranium sources (from explosive testing and resuspension of this residue in these soils), the uranium analysis was expanded to all Site 300 locations (including TFIR). Table 5-3 shows the median concentration of uranium-235 and uranium-238 for the air samples from the Site 300 network. (See Data Supplement Table 5-13 for monthly data.) The highest concentrations registered 58×10^{-7} µg/m^3 for uranium-235 and 70×10^{-5} µg/m^3 for uranium-238. These were observed in July at location 801E and represent less than 0.02% of the DCG for both isotopes. High values were also reported during July at EOBS and NPS. All three locations are positioned north to northeast from Bunker 850 where depleted uranium was used in a test shot in late July.

Table 5-4 shows the median concentration of tritium in air that was observed at the sampling location at Site 300 (see Data Supplement Table 5-14 for biweekly data). Site 300 concentrations are mostly below the detection limit and most likely represent background levels of tritium unaffected by local sources of tritium. Site 300 air tritium concentrations are no different statistically than those from the Livermore Valley location, HOSP.

Beryllium in Air

The monthly median beryllium concentrations are shown in Figure 5-7 with the Livermore perimeter locations. (See Data Supplement Table 5-15 for monthly data.) The highest beryllium concentration of 33.1 pg/m^3 occurred in October at location 801E. The annual median concentration for this location is 15.8 pg/m^3 or 0.16% of the federal and state ambient concentration limit, which is 10,000 pg/m^3. The highest monthly beryllium median was reported at TFIR at 21.4 pg/m^3. This is typical and believed to be the result of the location of the sampler which is situated in downtown Tracy and, therefore, accumulates more industrial and urban air pollutants than the other Site 300 locations.

Environmental Impact

The environmental impacts from both radioactive and nonradioactive effluents are described in this section.

Radioactive Materials

LLNL operations involving radioactive materials had little impact on radionuclide concentrations in ambient air during 2001. Radionuclide concentrations in air at the Livermore site and in the Livermore Valley were well below the levels that would cause concern for the environment or public health according to existing regulatory standards.

The diffuse tritium sources at B292, B331, B514, and B624 had a small, localized effect with minimal impact, if any, on the public. Any potential dose received by a member of the public from the diffuse sources is included in doses calculated for tritium concentrations at the Livermore site perimeter (see Table 5-8, Data Supplement). Tritium concentrations at the Livermore site perimeter, as well as off-site, were uniformly lower in 2001 than in 2000 when uncorrected data are compared. A maximum dose of 35 nSv/y to a member of the public at the Livermore site perimeter can be estimated based on the extraordinarily conservative assumption that the maximum biweekly corrected concentration (170 mBq/m^3) is maintained for an entire year and that a member of the public breathes that concentration for the entire year. This improbable inhalation dose to the public is just 0.035% of NESHAPs standard of 0.1 mSv/y arising as a result of releases of radionuclides to air from DOE facilities.

Even though the July samples detected uranium activity that was likely produced from a test shot, the concentrations of radionuclides measured around Site 300 and in the City of Tracy were well below the levels that would cause concern for the environment or public health according to existing regulatory standards.

Nonradioactive Materials

The concentrations of beryllium at both sites can be attributed to resuspension of surface soil containing naturally occurring beryllium. Local soils contain approximately 1 ppm of beryllium, and the air of the Livermore area and the Central Valley typically contains 10 to 100 µg/m^3 of particulates. Using a value of 50 µg/m^3 for an average dust load and 1 ppm for beryllium content of dust, a conservative airborne beryllium concentration of 50 pg/m^3 can be predicted. The overall annual medians for the Livermore site and Site 300 are 11.6 pg/m^3 and 11.7 pg/m^3, respectively. These data are lower than predicted, well below standards, and do not indicate the presence of a threat to the environment or public health.